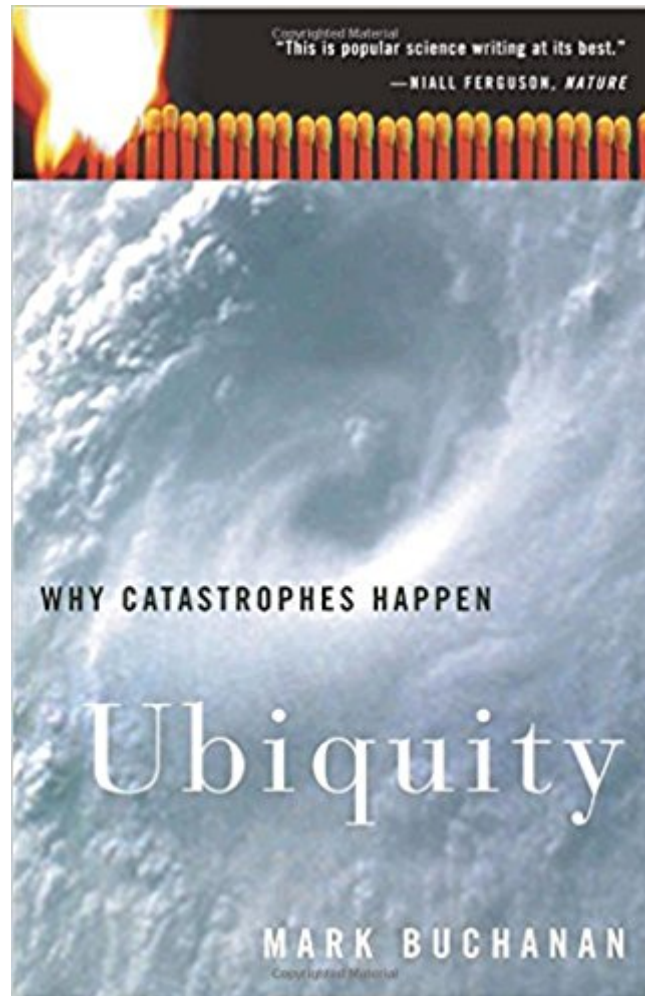




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# Ubiquity: Why Catastrophes Happen



## Synopsis

Why do catastrophes happen? What sets off earthquakes, for example? What about mass extinctions of species? The outbreak of major wars? Massive traffic jams that seem to appear out of nowhere? Why does the stock market periodically suffer dramatic crashes? Why do some forest fires become superheated infernos that rage totally out of control? Experts have never been able to explain the causes of any of these disasters. Now scientists have discovered that these seemingly unrelated cataclysms, both natural and human, almost certainly all happen for one fundamental reason. More than that, there is not and never will be any way to predict them. Critically acclaimed science journalist Mark Buchanan tells the fascinating story of the discovery that there is a natural structure of instability woven into the fabric of our world. From humble beginnings studying the physics of sandpiles, scientists have learned that an astonishing range of things—Earth's crust, cars on a highway, the market for stocks, and the tightly woven networks of human society—have a natural tendency to organize themselves into what's called the "critical state," in which they are poised on what Buchanan describes as the "knife-edge of instability." The more places scientists have looked for the critical state, the more places they've found it, and some believe that the pervasiveness of instability must now be seen as a fundamental feature of our world. Ubiquity is packed with stories of real-life catastrophes, such as the huge earthquake that in 1995 hit Kobe, Japan, killing 5,000 people; the forest fires that ravaged Yellowstone National Park in 1988; the stock market crash of 1987; the mass extinction that killed off the dinosaurs; and the outbreak of World War I. Combining literary flair with scientific rigor, Buchanan introduces the researchers who have pieced together the evidence of the critical state, explaining their ingenious work and unexpected insights in beautifully lucid prose. At the dawn of this new century, Buchanan reveals, we are witnessing the emergence of an extraordinarily powerful new field of science that will help us comprehend the bewildering and unruly rhythms that dominate our lives and may even lead to a true science of the dynamics of human culture and history. From the Hardcover edition.

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## Customer Reviews

Earthquakes, market crashes, hurricanes, wars: are these random forces of nature, or foreseeable blips on the radar screen of history? In this lively book, science journalist Mark Buchanan introduces readers to a developing branch of science that looks for order in what seems to be utmost chaos. In the late 1980s, three physicists set out to investigate the apparently inherent instability of complex systems. In a process that Buchanan illustrates by analogy with a sand pile, they discovered that these systems tend to arrive at a "critical state," after which point any random grain falling in just the right place can touch off an avalanche. So it is, Buchanan shows us, with the onset of world wars, economic shocks, traffic gridlock, and other dislocating events--all of which this new science may one day help predict. In clear and vigorous prose, Buchanan brings readers insights from nonequilibrium physics, offering a new way of seeing the "fingers of instability" that poke through the world's fabric--and that in turn make it such an interesting place. --Gregory McNamee --This text refers to an out of print or unavailable edition of this title.

Buchanan, an editor and writer for Nature and New Scientist, proposes to apply so-called nonequilibrium physics to cataclysms in human history. This form of physics involves the study of systems in perpetual imbalance, a state that makes it possible for a small shock to trigger a disproportionately huge response. Buchanan thinks human beings are just such systems, and that the earth itself is another, and that their shared history earthquakes, eclipsed economies, extinctions, etc. reflects it. Particularly interesting is his chapter on revolutionary changes in intellectual ideas, in which he discusses a study quantifying "cataclysmic" shifts in thought by tracking citations in scientific papers. Buchanan allows how daunting a task it is to quantify history and acknowledges critics who say such an approach tempts oversimplification and overlooks the role of free will in human affairs. Buchanan notes, "It is at least a step toward greater understanding to recognize that the tumultuous course of humanity need not be the product of some deeply malignant human madness, but of ordinary human nature and simple mathematics," and thus finishes his book with questions rather than raw numbers. (On-sale: Oct. 23) Copyright 2001

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This is not a hard book to read, but it is difficult to integrate into the way you look at the world. Mark Buchanan is a science writer who has worked on the editorial staff of *Nature* and as a features editor *New Scientist*. In this book he is writing about the development of a growing field of physics - complexity. Complexity is chaos in critical states. A critical state exists in a system that is not in equilibrium. You may have heard of the "butterfly effect". That is, there is a possibility that a butterfly flapping its wings in South America can cause a storm in Europe weeks later. However, that same butterfly can flap all in vain inside a closed balloon with no effects, other than maybe slightly increasing the temperature of the air in the balloon. The air inside the balloon is in equilibrium, even though the molecules exhibit chaotic behavior. The atmosphere is in a critical, i.e. non-equilibrium, state. A small perturbation somewhere can lead to very big changes. If the air inside the balloon is in equilibrium, its past, present and future are all the same. It has no "history". When things are in non-equilibrium, history matters since what happens now can never be washed away but affects the entire course of the future. The applications of this model extend from the piling of grains of sand in an hourglass to economics. "Despite what scientists had previously believed, might the critical state in fact be quite common? Could riddling lines of instability of a logically equivalent sort run through the Earth's crust, for example, through forests and ecosystems, and perhaps even through the somewhat more abstract "fabric" of our economics? Think of those first few crumbling rocks near Kobe, or that first insignificant dip in prices that triggered the stock market crash of 1987. Might these have been "sand grains" acting at another level? Could the special organization of the critical state explain why the world at large seems so susceptible to unpredictable upheavals? A decade of research by hundreds of other physicists has explored this question and taken the initial idea much further. There are many subtleties and twists in the story to which we shall come later in this book, but the basic message, roughly speaking, is simple: The peculiar and exceptionally unstable organization of the critical state does indeed seem to be ubiquitous in our world. Researchers in the past few years have found its mathematical fingerprints in the workings of all the upheavals I've mentioned so far, as well as in the spreading of epidemics, the flaring of traffic jams, the patterns by which instructions trickle down from managers to workers in an office, and in many other things. At the heart of our story, then, lies the discovery that networks of things of all atoms, molecules, species, people, and even ideas have a marked tendency to organize themselves along similar lines. On the basis of this insight, scientists are finally beginning to fathom what lies behind

tumultuous events of all sorts, and to see patterns at work here where they have never seen them before."The mathematical models of this science don't really exist yet, and may never exist. We have empirical observations and we have games. The empirical data suggests that all these phenomena follow a power curve, and all with roughly the same shape. For example, looking at earthquakes, as the strength of the earthquake doubles, the frequency of occurrence drops by one fourth. This simple rule seems to apply to many examples. So what does this have to do with creativity, strategy, leadership and innovation in organization? Well, I'm not sure yet. My intuition tells me that this is very important to those concepts. It may help us understand the frequency of occurrence of breakthrough ideas and innovation. It may help explain why some innovations cause such change and others do not. It may help produce better strategies to deal with chaotic and unstable markets. And, it may provide lessons for leaders in chaotic times.

Buchanan's major contribution is his relation of scientific phenomena to human systems. This reminds me of the Ancient Greek studies that produced the Golden Mean and then applied it to much of life. Earthquakes and landslides in particular, perhaps because there allow for certain types of measurement, were used to describe cyclical events. If the pressure builds on a system past a certain point, any small event might trigger the violent re-ordering of the system. Of course, all that read this book are probably thinking about the market. Market gurus heavily recommended this book. The implication is that we cannot predict when a financial accident will occur, only that there's always another one going to happen. Also, the higher the level of the market, relative to other things, the greater the pressure on it to experience a financial accident that could begin from an otherwise non-significant event. The state of the markets today seem to support Buchanan's ideas. One sees something in the news about a small country or a single company that appears unable to meet its debt obligations. Then the markets decline perhaps 3% and threaten to make it the big one if other bad news piggybacks on this one. As a result of reading this book, I'm trolling the sites that collect negative news that might potentially sink markets, because I believe those events are out there. I'm avoiding news on celebrities, which is what some great powers have determined will dominate our major news media. But Buchanan's point is to expect the unexpected anyway. Looking for it might be futile since the big events occur quickly and without warning.

Buchanan will show you a world very different than you think you live in if you have taken on the dominant "linear" worldview pushed by most popular science books and TV talking heads. Unexpected, unforeseeable, hugely consequential events occur relentlessly for no special reason at

all, shaping the long term dynamics of the systems underlying our existence in hugely surprising ways, and yet we continue to order our lives and look to the future as if it will be a linear extrapolation of what has come before. Buchanan brings clarity and insight, as well as creative suggestions of his own on the subject of self organized criticality (SOC) and its implications for the world beyond physics. This is a popular book, so don't expect to understand every technical detail of SOC or power laws after reading it. There are other sources for that, and following the references Buchanan provides, and where they lead up to the present day, will get you there. Do expect to be unusually thoroughly informed and entertained by this book, and to come away with a solid qualitative understanding of SOC and its consequences. This book continues to be relevant more than a decade after its publication as a lucent entryway into the deceptively simple ideas of Per Bak and their earth shattering consequences for the dominant worldview and the future of our civilization.

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